

REMARKS

This responds to the Office Action mailed on June 15, 2005. By this response, claims 1, 14 and 35 are amended. No claims are added. Claim 6 was canceled. As a result, claims 1-5 and 7-19 and 28-39 are now pending in this application. No new matter was added. Reconsideration of this application is requested in view of the above amendments and the following remarks.

§112 Rejection of the Claims

A. Rejection under 35 USC § 112: Claim 6 was rejected under 35 USC § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

B. Response to rejection under 35 USC § 112: Claim 6 has been canceled in this response, thereby obviating the rejection of claim 6 under 35 USC § 112, second paragraph.

§103 Rejection of the Claims

A. Rejection under 35 USC § 103(a): Claims 1-5, 8-9, 12-14, 16, 18, 19, and 31-40 were rejected in compliance with 35 USC § 112, are rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045) in view of Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA).

B. Response to Rejection under 35 USC § 103(a): In order for the Examiner to establish a *prima facie* case of obviousness, three base criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference or references must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both

be found in the prior art, and not based on applicant's disclosure. *M.P.E.P.* § 2142 (citing *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991)).

Claim 1, as amended, now recites "...a solder ball formed on at least one of the array of pads, at least one of the array of pads including a solderable diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad to the solder ball during a solder reflow process." Applicant submits that the combination of Marlin, the admitted prior art (APA), and Paunovic et al. (U.S. 5,294,486) does not teach or suggest all the elements of claim 1. The Examiner admits that Marlin does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process (see top of page 7 in the Office Action dated June 15, 2005). The Marlin reference teaches a layer to prevent diffusion (See column 2, line 7 of the Marlin reference). Paunovic et al. also does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad to the solder ball during a solder reflow process. It should be pointed out that Paunovic et al. teaches use of the diffusion barriers to prevent or limit interaction between the layers of a stack of films. More specifically, Paunovic et al. teaches:

"The diffusion barrier structure is usually a single layer positioned in a series of layers that operates to control, prevent or retard the travel, within the film layers, of atoms from one location to another where the presence of those atoms is detrimental.

Other barrier structure layers may be inserted in a thin film stack to prevent or produce compound formation between potentially interacting layers." (See column 1, lines 33-40 of Paunovic et al.)

The Paunovic et al. reference does not deal with the out-diffusion of the electrically conductive material from the pad to the solderball. Paunovic et al. deals with controlling the movement of atoms between layers in the pad. Specifically, Paunovic et al. teaches :

"...an improved barrier is provided in a stack 10 to keep atoms from a Cu conductivity layer 11 from diffusing into and affecting the properties of an Au corrosion inhibiting and solderability enhancing layer 12, effectively reducing the Cu present in the Au layer 12 after annealing for 2 hrs. at 400.degree. C. to about 0.2 to 0.44%. The improved barrier 13 is made up of three layers, an interlayer 14

of Au separated from the Cu layer 11 on one side by a layer 15 of Ni and separated from the Au layer on the other side by a layer 16 of Ni.” (See column 3, line 65 to column 4, line 8 of the Paunovic et al. reference).

The Paunovic et al. reference teaches a three layer barrier that prevents movement of atoms within the film during an annealing process. In fact, the Paunovic et al. reference stresses the fact that the properties of the solderability layer 12 are to remain unchanged. Therefore, in the Paunovic et al. reference, the barrier is not for inhibiting diffusion between the solder ball and the film but to control diffusion within the film. The APA also does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. In fact, the APA also does not mention diffusion barriers and therefore does not supply this missing element. The combination of Marlin, Paunovic et al., and the APA fails to teach or suggest all the claim limitations of claim 1.

In addition, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine reference teachings to yield applicant’s invention. In fact, to modify the references as suggested by the Examiner would destroy the ability of Paunovic et al. to control the movement of atoms between films. This is evidence against such a motivation or suggestion.

Accordingly, the Examiner has failed to make out a proper prima facie case of obviousness and, as a result, claim 1 overcomes the Examiner’s rejection under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045) in view of Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA).

Claims 2-5, 8, 9, 12 and 13 depend, either directly, or from claim 1 and include the limitations of claim 1 by their dependency. As a result, applicant believes that the Examiner’s rejection of claims 2-5, 8, 9, 12 and 13 are now also improper for the reasons set forth above with respect to claim 1.

Claim 14 as now amended recites “...a diffusion retarding layer placed over the at least one pad; and a layer of gold over the at least one pad diffusion retarding layer, wherein the diffusion layer is adapted to control the out-diffusion of copper material from the at least one pad.” As mentioned above, Marlin fails to teach or suggest a diffusion layer for controlling the out-diffusion of pad material, as admitted by the Examiner (see top of page 7 of the June 6, 2005

Office Action). Neither the APA or the Puanovic et al. includes this element. As a result, the Examiner fails to make out a proper prima facie case of obviousness since the combination of references fails to teach or suggest all of the claim elements of the invention of claim 14.

Claims 16, 18, and 19 depend directly from claim 14 and include the limitations of claim 14 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 14, 16, 18, and 19 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 31 recites "...means to retard diffusion of the copper associated with the copper pad adapted to retard the out-diffusion of the copper from the pad during a solder reflow process." Claim 31 overcomes the Examiner's rejection under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045) in view of Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA) for the same reasons as set forth above with respect to claims 1 and 14. In addition, the Paunovic et al. reference teaches a three layer barrier that prevents movement of atoms within the film during an annealing process rather than "means to retard diffusion ...adapted to retard the out-diffusion of the copper from the pad during a solder reflow process ." (Claim 31) Consequently, the combination of Marlin and the APA and Paunovic et al. does not teach or suggest all the elements of claim 31.

Claims 32-34 depend directly from claim 31 and include the limitations of claim 31 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 32-34 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 35 recites "...means to retard out-diffusion of the copper associated with the copper pad ..." Again, the Examiner admits that Marlin fails to teach a retarding layer being functional as the layer for controlling out-diffusion of the electrically conductive material from the at least one pad (See top of page 7 of the June 15, 2005 Office Action). The Paunovic et al. reference uses diffusion layers to control movement of atoms between thin films rather than the out-diffusion from the pad. The APA does not add the layer as claimed. Accordingly, the combination of Marlin, Paunovic et al. and the APA does not teach or suggest all the elements of claim 31. There is also no suggestion or motivation either in the references themselves or the in the knowledge generally available to one of ordinary skill in the art, to combine reference

teachings. Accordingly, the rejection of claim 35 overcomes the Examiner's rejection as obvious since the Examiner fails to set forth a proper *prima facie* case of obviousness.

Claims 36-39 depend, either directly or indirectly, from claim 35 and include the limitations of claim 35 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 36-39 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 40 was previously canceled in amendment filed February 22, 2005, thereby making the rejection moot with respect to this claim.

As a result, the rejection of claims 1-5, 8-9, 12-14, 16, 18 -19, and 31- 39 under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046) in view of Paunovic et al. (U.S. 5,294,486) is overcome.

C. Rejection under 35 USC § 103(a): Claims 10 and 11 were insofar as being in compliance with 35 USC § 112, are rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045), Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA) as applied to claim 1 above, and further in view of Andricacos et al. (U.S. 6,224,690).

D. Response to Rejection under 35 USC § 103(a): Claims 10 and 11 depend indirectly from claim 1 and include the limitations of claim 1 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 10 and 11 are now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, and the Andricacos et al. reference fails to show all the elements of each of these claims. Specifically, the combination of Marlin, Paunovic et al., the APA, and the Andricacos et al. reference does not teach or suggest a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. As a result, Applicant submits that claims 10 and 11 now overcome the Examiner's rejection as obvious for the same reasons as set forth in **Response B.** above with respect to claim 1.

E. Rejection under 35 USC § 103(a): Claims 6, 7, 15, and 17 were insofar as being in compliance with 35 USC § 112, are rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045), Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA) as applied to claims 1 and 14 above, and further in view of Andricacos et al. (U.S. 6,224,690) and Okamoto et al. (U.S. 5,521,438).

F. Response to Rejection under 35 USC § 103(a): Claim 6 was canceled in this response. Claim 7 depends directly from claim 1 and includes the limitations of claim 1 by its dependency. As a result, applicant believes that the Examiner's rejection of claim 7 is now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, the Andricacos et al. reference, and the Okamoto et al. reference fails to show all the elements of each of these claims. Specifically, the combination of Marlin, the Paunovic et al. reference, the APA, the Andricacos et al., and the Okamoto et al. reference does not teach or suggest a solder ball formed on at least one of the array of pads, at least one of the array of pads including a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad to the solderball during a solder reflow process. The Okamoto et al. reference is directed toward joining a metallic member, such as an input/output terminal, by solder to a ceramic base by way of a stress layer (see abstract). The Examiner contends that the structure taught in the Okamoto et al. reference is for preventing further diffusion of an intermetallic, however, there is no mention of diffusion in the Okamoto et al. reference. Furthermore, Okamoto et al. also fails to teach or suggest a solder ball formed on at least one of the array of pads, at least one of the array of pads including a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad to the solderball during a solder reflow process. Accordingly, claim 7 now overcomes the Examiner's rejection since the Examiner has failed to make a proper *prima facie* case of obviousness.

Claims 15 and 17 depend directly from claim 14 and include the limitations of claim 14 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 15 and 17 are now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, the Andricacos et al. reference, and the Okamoto et al. reference fails to

show all the elements of each of these claims. Specifically, the combination of Marlin, Paunovic et al., the APA, Andricacos et al., and the Okamoto et al. references do not teach or suggest a diffusion retarding layer placed over the at least one pad, and a layer of gold over the at least one pad diffusion retarding layer, wherein the diffusion layer is adapted to control the out-diffusion of copper material from the at least one pad. The Okamoto et al reference does not mention a diffusion barrier. In fact, Okamoto et al. also fails to teach or suggest a solder ball formed on at least one of the array of pads. As a result, the reasons set forth in **Response B.** above that discuss the reasons claim 14 is not obvious is applicable to the rejection of claims 15 and 17. Accordingly, claims 15 and 17 now overcomes the Examiner's rejection, since the Examiner has failed to make a proper *prima facie* case of obviousness.

G. Rejection under 35 USC § 103(a): Claims 28-30 were rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,045), Paunovic et al. (U.S. 5,294,486) and admitted prior art (APA) as applied to claim 1, and further in view of Andricacos et al. (U.S. 6,224,690) and Shimokawa et al. (U.S. 2002/0163085).

H. Response to Rejection under 35 USC § 103(a): Claim 28 recites "...a diffusion retarding layer placed on at least one of the array of pads; and solder placed on at least one of the array of pads, the solder and the pad including an intermetallic compound including Ni-Sn (Ni_3Sn_4) and Sn-Fe." The references cited do not teach or suggest the combination of a diffusion retarding layer and the specific intermetallic alloys recited in claim 28. Accordingly, claim 28 overcomes the Examiner's rejection under 35 USC 103(a) since the combination of elements is not found in the references individually or in combination. Claims 29 and 30 depend directly from claim 28 and add further limitations to the invention. As a result, claims 29 and 30 are also thought to overcome the Examiner's rejection.

Conclusion

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney ((612) 373-6977) to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KUM FOO LEONG ET AL.

By their Representatives,

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.

Attorneys for Intel Corporation

P.O. Box 2938

Minneapolis, Minnesota 55402

(612) 373-6977

Date 9/15/05

By Richard E. Billion

Richard E. Billion

Reg. No. 32,836

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 15th day of September, 2005.

Amy Moriarty
Name

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